WEEKLY TEST MEDICAL PLUS -03 TEST - 10 RAJPUR SOLUTION Date 22-09-2019

[PHYSICS]

1.

Given that,

$\vec{F} = (2t\hat{i} + 3t^2\hat{j})$ and $\vec{a} = 2t\hat{i} + 3t^2\hat{j}$

Hence, $v = \int_0^t a\,dt = t^2\hat{i} + t^3\hat{j}$

$\therefore \quad P = \vec{F}\cdot\vec{v} = 2t\cdot t^2 + 3t^2\cdot t^3 = 2t^3 + 3t^5$

2.

A rocket propulsion is based on the conservation of linear momentum.

3.

Here, $m_1 = 18\text{ kg}, m_2 = 12\text{ kg}, v_1 = 6\text{ m s}^{-1}$

In accordance with conservation law of momentum,

$$v_2 = \frac{m_1v_1}{m_2} = \frac{18\times 6}{12} = 9\text{ m/s}$$

$\therefore$ KE of 12 kg mass piece

$$K_2 = \frac{1}{2}m_2v_2^2 = \frac{1}{2}\times 12\times(9)^2 = 486\text{ J.}$$

4.

According to conservation of momentum

$$m_1v_1 + m_2v_2 = (m_1 + m_2)v,$$

where v is common velocity of the two bodies.

$$m_1 = 0.1\text{ kg}, m_2 = 0.4\text{ kg}$$

$$v_1 = 1\text{ m/s}, v_2 = -0.1\text{ m/s}$$

$\therefore \quad 0.1\times 1 + 0.4\times(-0.1) = (0.1 + 0.4)v$

or $\quad 0.1 - 0.04 = 0.5v,$

$$v = \frac{0.06}{0.5} = 0.12\text{ m/s.}$$

Hence, distance covered = 0.12 × 10 = 1.2 m

5.

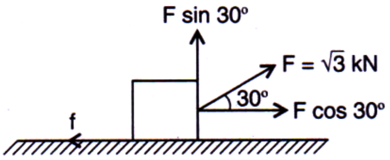
Height attained after n jumps

$$h' = e^{2n}h$$

As $n = 2$

Hence $\quad h' = e^{2+2}h = e^4h.$

6.



The component of applied force F in the direction of motion is $F\cos 30^\circ$.

The work done by the applied force is,

$$W = (F\cos 30^\circ)S = \sqrt{3}\times 10^3 \times \frac{\sqrt{3}}{2}\times 10\,\text{J}$$

$$= 15\times 10^3\,\text{J} = 15\,\text{kJ}.$$

7.

According to work-energy theorem

W = Change in kinetic energy

$$FS\cos\theta = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$$

Substituting the given values, we get

$$20\times 4\times\cos\theta = 40 - 0 \qquad (\because u = 0)$$

$$\cos\theta = \frac{40}{80} = \frac{1}{2}$$

$$\theta = \cos^{-1}\left(\frac{1}{2}\right) = 60^\circ$$

8.

9.

10.

$$S = \frac{1}{3}t^2$$

$$v = \frac{dS}{dt} = \frac{2}{3}t\,; \qquad a = \frac{d^2S}{dt^2} = \frac{2}{3}$$

$$F = ma = 3\times\frac{2}{3} = 2\,\text{N}\,; \quad \text{Work} = 2\times\frac{1}{3}t^2$$

At $t = 2$ seconds : $\text{Work} = 2\times\frac{1}{3}\times 2\times 2 = \frac{8}{3}\,\text{J}.$

11.

$$F \propto \frac{1}{v}$$

$$F = \frac{C}{v}$$

where C is a constant of proportionality.

$\therefore \qquad ma = \frac{C}{v}$

or $\qquad m\frac{dv}{dt} = \frac{C}{v}$

$$v\,dv = \frac{C\,dt}{m}$$

Integrating both sides, we get,

$$\frac{v^2}{2} = \frac{Ct}{m}$$

or $\qquad \frac{1}{2}mv^2 = Ct$

or $\qquad$ Kinetic energy $K = \frac{1}{2}mv^2 = Ct$

or $\qquad K \propto t$

12.

13.

Mass of neutron is, $m_1 = m$

Mass of alpha particle is, $m_2 = 4\ m$

Given: $u_1 = v,\ u_2 = 0$

The final velocity of the neutron after collision is given by:

$$v_1 = \frac{(m_1 - m_2)u_1}{m_1 + m_2} + \frac{2m_2u_2}{m_1 + m_2}$$

$$= \frac{(m - 4m)v}{m + 4m} + \frac{2 \times 4m \times 0}{m + 4m} = -\frac{3v}{5}$$

14.

Force, $\vec{F} = -2\hat{i} + 15\hat{j} + 6\hat{k}$ N

Displacement, $\vec{s} = 0\hat{i} + 10\hat{j} + 0\hat{k}$ m

$\therefore$work done $W = \vec{F} \cdot \vec{s}$

$$= (-2\hat{i} + 15\hat{j} + 6\hat{k})(0\hat{i} + 10\hat{j} + 0\hat{k}) = 150 \text{ J.}$$

15.

16.

Height attained after first bounce:

$$h_1 = e^2 h$$

$\therefore$ $h_1 = (0.9)^2 \times 20 = 0.9 \times 0.9 \times 20 = 16.2$ m.

17.

$(50)2 = (50 + 200)V$

$\therefore$ $V = \frac{2}{5}\ \text{ms}^{-1}$

18.

19.

After collision, $v_2 = \left(\frac{1+e}{2}\right)u$

and $v_1 = \left(\frac{1-e}{2}\right)u$

Here, u = initial speed of ball 1

$$v_2 = 2v_1, \text{ when } e = \frac{1}{3}.$$

20.

21.

$mv_0 = (m + m)v$ or $v = v_0/2$

$$T = \frac{2mv^2}{l} + 2mg = \frac{2mv_0^2}{4l} + 2mg$$

$$= \frac{m(2gl)}{2l} + 2mg = 3mg$$

Initially, the tension $= T_0 = mg$

$\therefore$Increase in tension $= 2mg$.

22.

The time elapsed from the moment it is dropped to the second impact with the floor is,

$$t = \sqrt{\frac{2h}{g}}\,(1 + 2e)$$

where h is the initial height of the body from the ground

$$1.03 = \sqrt{\frac{2}{9.8}}\,(1 + 2e)$$

Solving, we get; $e = 0.64$

23.

24.

$$m_1u_1 + m_2u_2 = (m_1 + m_2)V$$

$$2 \times 6 + 2 \times 0 = (2 + 2)V$$

or $$V = 3 \text{ m s}^{-1}$$

$$E = \frac{1}{2}(m_1 + m_2)V^2$$

$$= \frac{1}{2} \times 4 \times 9 = 18 \text{ J.}$$

25.

26.

27.

28.

Relative velocity of separation = relative velocity of approach

$= v$ (as $e = 1$)

$\therefore$ Time of next collision $= \dfrac{2\pi r}{v}$.

29.

As in a perfectly inelastic collision, two bodies stick together after the collision; hence they move with same velocity after the collision, *i.e.*, their relative velocity after the impact is zero.

30.

After striking at the floor the ball cannot return with double the velocity because there will be some loss of KE of the ball after the collision which will appear in the form of sound energy, heat energy, etc.

31.

32.

As balls rebound with same speed, hence impulse imparted to each ball $= 2p = 2mv = 2 \times 0.06 \times 4$ $= 0.48$ kg-m/s .

33.

Velocity, $v = \dfrac{\text{displacement}}{\text{time}} = \dfrac{6}{3} = 2$ m/s

$\therefore$ Power, $P = Fv = 10 \times 2 = 20$ W.

34.

TE = PE at height h is mgh

At height 3*h*/4: $\text{PE} = mg\dfrac{3h}{4}$

$$\text{KE} = \text{TE} - \text{PE} = mg\frac{h}{4}$$

$\therefore$ $$\frac{\text{KE}}{\text{PE}} = \frac{1}{3} = 1:3.$$

35.

Here, ball and the earth form a system and gravitational force on the ball is an internal force.

Hence, $\vec{p}_S = \vec{p}_B + \vec{p}_E =$ constant

As initially both the ball and the earth are at rest, hence,

$\vec{p}_B + \vec{p}_E = 0$ or $m\vec{v} + M\vec{V} = 0$

or $$\vec{V} = -\frac{m}{M}\vec{v}$$

i.e., velocity of the earth is opposite to that of ball in direction and much smaller in magnitude (as $M >> m$). So, if ball moves away from the earth, the earth also moves away from the ball and if ball moves towards the earth, the earth also moves towards ball.

36.

According to law of conservation of momentum

$$0 = m_1v_1 + m_2v_2 \quad \ldots\text{(i)}$$

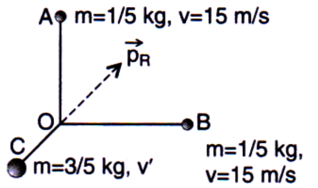
$$K_2 = \frac{1}{2}m_2v_2^2 = \frac{1}{2}\frac{m_2^2v_2^2}{m_2} = \frac{m_1^2v_1^2}{2m_2}$$

$$= \frac{(3)^2 \times (16)^2}{2 \times 6} = 192 \text{ J.}$$

37.

Momentum of $A = \frac{1}{5} \times 15 = 3$ kg-m/sec

Momentum of $B = \frac{1}{5} \times 15 = 3$ kg-m/sec



$\therefore$ Resultant momentum

$$p_R = \sqrt{3^2 + 3^2} = 3\sqrt{2} \text{ kg-m/sec}$$

Now, C must have a momentum $= 3\sqrt{2}$ kg-m/sec along OC.

$\therefore$ $$\frac{3}{5}v' = 3\sqrt{2} \text{ or } v' = 5\sqrt{2} \text{ m/s.}$$

38.

$$Fs = \frac{1}{2}mV^2$$

or $$\frac{mv}{t}s = \frac{1}{2}mV^2 \text{ or } \frac{s}{t} \propto V$$

$\therefore$ $$\frac{V_1}{V_2} = \frac{s_1}{t_1} \times \frac{t_2}{s_2} = \frac{(s_2/3) \times t_2}{2t_2 \times s_2} = \frac{1}{6}.$$

39.

$P = Fv = 4500 \times 2 = 9000 = 9$ kW.

40.

At a height $\frac{4h}{5}$, the potential energy $= mg \times \frac{4h}{5}$

Total energy $= mgh$

$\therefore$ KE at that height $= mgh - \frac{4}{5}mgh = \frac{1}{5}mgh$

Ratio of KE and PE $= \frac{1}{5}mgh / \frac{4}{5}mgh = 1:4$.

41.

$$dU = -dW$$

dU = Change in potential energy

dW = Work done by conservative forces

Hence, work done by conservative forces on a system is equal to the negative of the change in potential energy.

42.

43.

By work-energy theorem,

$$W = \Delta KE$$

$$W_g + W_r = \frac{1}{2}mv^2$$

$$mgh + W_r = \frac{1}{2}mv^2 \quad \text{or} \quad W_r = \frac{1}{2}mv^2 - mgh$$

$$= \frac{1}{2} \times 5 \times (10)^2 - 5 \times 9.8 \times 20 = -730 \text{ J.}$$

44.

Work done by man in one hour = power $\times$ time

$= 9.8 \times 1 \times 60 \times 60$ J

Work done by man in raising one brick

$= mgh = 2.5 \times 9.8 \times 3.6$ J

Number of bricks, $N = \frac{9.8 \times 1 \times 60 \times 60}{2.5 \times 9.8 \times 3.6} = 400$.

45.

$$\text{Power} = \left(\frac{mgh + \frac{1}{2}mV^2}{t} \right)$$

$$= \frac{1000 \times 10 \times 10 + \frac{1}{2} \times 1000 \times 10 \times 10}{60}$$

$$= \frac{15,000}{6} \text{ watt}$$

But 1 watt $= \frac{1}{746}$ HP

$\therefore$ Power $= \frac{15000}{6 \times 746} = 3.33$ HP

[CHEMISTRY]

46.

$\Delta H = \Delta E + \Delta n_g RT$

For, $C_2H_4(g) + 3O_2(g) \longrightarrow 2CO_2(g) + 2H_2O(l)$

$\Delta E = -1415\,kJ,\ \ \Delta n_g = 2-(3+1) = -2$

Mol. wt. of $C_2H_4 = 28\,g$

$\Delta H = -1415 - 2\times\frac{8.3}{1000}\times 300$

$= -1415 - 4.98 = -1419.98\,kJ\,mol^{-1}$

47.

31.75 g Cu ≡ −106.15 kJ

63.5 g Cu (1 mol Cu from balanced equation) $\equiv -\frac{106.15\times 63.5}{31.75}$ kJ = **−212.30 kJ**

48.

$\Delta H = \Delta E + \Delta n_g RT$

For $H_2O(l) \xrightarrow{373\,K} H_2O\,(g)$

$\Delta H = 37.5 + 1\times 8.3\times 373$

$= 37.5 + 3095.9$

$= 3133.4\ J = \mathbf{3.1334\ kJ}$

49.

$CH_4(g) + 2O_2(g) \longrightarrow CO_2(g) + 2H_2O(g);$ $\Delta H = -x\,kJ$ ...(i)

$C(graphite) + O_2(g) \longrightarrow CO_2(g);$ $\Delta H = -y\,kJ$ ...(ii)

$H_2(g) + \frac{1}{2}O_2(g) \longrightarrow H_2O(l);$ $\Delta H = -z\,kJ$ ...(iii)

Eqn. [(ii) + 2 × (iii) − (i)] give

$C(graphite) + 2H_2(g) \longrightarrow CH_4(g)$ ...(iv)

Hence, $\Delta H = (-y) + 2(-z) - (-x)$

$= \mathbf{(-y - 2z + x)\ kJ}$

50.

$\Delta C_P = \frac{\Delta H_2 - \Delta H_1}{T_2 - T_1} = \frac{-125-(-50)}{373-273} = \frac{-75}{100} = \mathbf{-0.75\ kJ\ K^{-1}}$

51.

$C(s) + \frac{1}{2}O_2(g) \longrightarrow CO(g)$

$\Delta n_g = \frac{1}{2}$

$\Delta H - \Delta U = \Delta n_g RT$

$= \frac{1}{2}\times 8.314\times 298 = \mathbf{+1238.78\ J\ mol^{-1}}$

52.

More negative the enthalpy of formation, stabler is the compound.

53.

Number of moles of gaseous substances are not equal on reactant and product side.

54.

$$CH_3OH + \frac{3}{2}O_2 \longrightarrow CO_2 + 2H_2O\,;\ \Delta H = -723\,kJ$$

$\frac{3}{2}$ mol $O_2 \equiv 723$ kJ enthalpy released

$$1\ mol\ O_2 = \frac{723 \times 2}{3} = \mathbf{482\ kJ}$$

55.

Number of moles of gaseous substances on both sides are equal. $\Delta n_g = 0$

56.

$$W = -P\Delta V = -3\,atm \times (6-4)\,dm^3 = -6\,atm\,L = -6 \times 101.325\,J = \mathbf{-608\ J}$$

57.

$$C(s) + O_2(g) \longrightarrow CO_2(g)\,; \qquad \Delta H_1 = -94\,kcal$$

$$H_2(g) + \frac{1}{2}O_2(g) \longrightarrow H_2O(l)\,; \qquad \Delta H_2 = -68\,kcal$$

$$CH_4(g) + 2O_2(g) \longrightarrow CO_2(g) + 2H_2O(l)\,; \qquad \Delta H_3 = -213\,kcal$$

For $C(s) + 2H_2(g) \longrightarrow CH_4(g)$,

$$\Delta H = \Delta H_1 + 2\Delta H_2 - \Delta H_3 = (-94) + (-136) - (-213) = \mathbf{-17\ kcal}$$

88.

$$Fe + 2HCl \longrightarrow FeCl_2 + H_2$$

Moles of Fe $= \frac{112}{56} = 2$

$\therefore$ Moles of H_2 formed $= 2$

Work done $= P(V_2 - V_1) = P \cdot V_{H_2}$

$\{V_2 = V_{H_2}$ and $V_1 = 0$ (for solid + liquid state)$\}$

$= P \times \frac{nRT}{P} = nRT \qquad \{\because P_{H_2} \times V = nRT\}$

$= 2 \times 2 \times 300 = 1200$ cal

59.

$$\underset{342\,g}{C_{12}H_{22}O_{11}} + 12O_2 \longrightarrow 12CO_2 + 11H_2O\,;$$

$\Delta H = -1349$ kcal

Amount of sugar needed

$$= \frac{2870 \times 342}{1349} = 727.6\ g$$

60. For isothermal reversible expansion of an ideal gas volume V_1 to V_2 the work done is given as :

61. For adiabatic expansion, $\frac{T_2}{T_1} = \left(\frac{V_1}{V_2}\right)^{\gamma - 1}$

Here, for CO_2 (triatomic gas), $\gamma = 1.33$

$$\therefore \left(\frac{150}{300}\right) = \left(\frac{10}{V_2}\right)^{0.33}$$

or $\left(\frac{1}{2}\right) = \left(\frac{10}{V_2}\right)^{0.33} \Rightarrow \left(\frac{1}{2}\right)^3 = \frac{10}{V_2} \Rightarrow \frac{1}{8} = \frac{10}{V_2} \Rightarrow V_2 = 80$ L

62 $W = -2.303 nRT \log \frac{V_2}{V_1}$

$= -2.303 \times 1 \times 8.314 \times 300 \times \log \frac{20}{10}$

$= -2.303 \times 8.314 \times 300 \times 0.3010 = -1729$ joules

Work done = – 1729 joules

63. Given : Standard heat of vaporisation,

$\Delta H_v^\circ = 40.79 \text{ kJ mol}^{-1}$; Mass of water = 80 g

No. of moles of water $= \frac{80 \text{ g}}{18 \text{ g mol}^{-1}} = 4.44$ mol

Now, heat required to vaporise one mole of water = 40.79 kJ

∴ Heat required to vaporise 4.44 moles of water

$= 4.44 \times 40.79 = 1.81 \times 10^2$ kJ

64.

65. As internal energy is a function of temperature, therefore $\Delta U = 0$

66.

67. For an adiabatic process neither heat enters or leaves the system

∴ $q = 0$.

68.

ΔE and ΔH both are zero in case of cyclic process. [Also, for isothermal free or reversible expansion of ideal gas, ΔE and ΔH both are zero].

69.

70.

In case of thermodynamic equilibrium $\Delta V, \Delta P, \Delta T$ and Δn all have to be zero.

71.

72.

1 litre-atm = 24.2 calorie

1 calorie = 4.1868 joule

1 joule = 10^7 erg

73.

$W_{\text{expansion}} = -P\Delta V$

$= -(1 \times 10^5 \text{Nm}^{-2})[(1 \times 10^{-2} - 1 \times 10^{-3}) \text{m}^3]$

$= -10^5 \times (10 \times 10^{-3} - 1 \times 10^{-3}) \text{ Nm}$

$= -10^5 \times 9 \times 10^{-3} \text{ J} = -9 \times 10^2 \text{ J} = \mathbf{-900 \text{ J}}$

74.

$q = 300$ calorie

$W = -P\Delta V = -1 \times 10$ litre-atm $= -10 \times 24.2$ cal $= -242$ cal

$\Delta E = q + W = 300 - 242 = \mathbf{58 \text{ cal}}$

75.

For isothermal reversible expansion $W = -2.303\, nRT \log \frac{P_1}{P_2}$

For all factors being same, $W \propto \frac{1}{\text{Molecular weight}}$

NO and $\mathbf{C_2H_6}$ both have equal molecular weights 30 g mol^{-1}.

76.

$q = +\mathbf{200\ J}$

$W = -P\Delta V = -1\times(20-10) = -10\,\text{atm L}$

$= -10\times 101.3\ \text{J} = \mathbf{-1013\ J}$

$\Delta E = q + W = (200-1013)\ \text{J} = \mathbf{-813\ J}$

77.

ΔH for isothermal free expansion is **zero.**

78.

$$W = -\ 2.303nRT\log\frac{V_2}{V_1}$$

$$= -\ 2.303\times 2\times 8.314\times 300\times \log\frac{50}{5}\ \text{joule}$$

$$= -\ 11488.285\ \text{J} \simeq \mathbf{-11.5\ kJ}$$

79.

As the system starts from A and reaches to A again, whatever the stages may be net energy change is **zero**.

80.